agricultural research

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Plant Treasury

American agriculture is deeply indebted to a bank—a living storehouse of some 380,000 of the world's plant treasures. Among its deposits are new food crops, drugs for healing, and raw materials for industry. The bank's most vital service, however, is supplying scientists with the breeding material they need to improve and safeguard our crops.

Many of the bank's treasures come from American plant explorers who venture into the wildest regions of the earth. Items come also from foreign scientists, Public Law 480 projects, and our own missionaries and businessmen abroad. Thousands of new items are deposited each year at the bank's headquarters, the Beltsville Agricultural Research Center.

Plant introduction, however, is an old story in the New World. This activity stems not from choice but necessity; paradoxically, of all the major crops making up the bounty of U.S. agriculture, not one originated within our borders. Corn, for example, is a native of South America, soybeans of China, wheat of the Middle East.

Agriculture has never been more reliant upon the collection and preservation of still-existent germ plasm. We must save from extinction the seeds of wild and primitive plants endowed with irreplaceable genetic qualities. They provide the ultimate safeguard against the risks inherent with the growth of vast monocultures wherein billions of plants of a single crop species sweep across thousands of acres, the plants all genetically similar. Narrow genetic bases make possible today's high crop yields, but also increase crop vulnerability to production losses—even epidemics. Thus the plant breeder requires a supply of diverse genes to maintain equilibrium status with constantly mutating pathogens and insect pests and to meet ever burgeoning global needs for food.

The American plant breeder's prime channel for diverse genes is the Beltsville Agricultural Research Center. Here begins the systematic task of preserving plant stocks for the years to come. Each incoming item is carefully checked for disease to protect our established crops. A plant introduction number is assigned to each screened item, then it is sent to one of four regional stations for increase, evaluation, distribution, and maintenance. Some seed goes to the National Seed Storage Laboratory, Fort Collins, Colo., and to various collections for long-term storage of germ plasm. Paying as well as receiving has become a vital function of the germ plasm bank. Last year, for example, about 35,000 items went to 110 countries. These cooperative efforts are a vital part of the worldwide effort to banish hunger in our time.

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COVER: Every part familiar to plant breeders, the alfalfa plant has been the subject of research activities for many years. Now ARS scientists have developed a new variety—Arc—that is resistant to the fungal disease anthracnose, which affects some 4 million acres of alfalfa (PN–2869). Article begins on page 3.

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Fending off anthracnose

ARC, a new pest-resistant variety of alfalfa, may increase the value of the Nation's Number One forage crop by more than $200 million annually.

Outstanding resistance to anthracnose is the main advantage of Arc over present varieties of alfalfa. Many plants are hosts for different kinds of anthracnose. However, alfalfa in the eastern half of the United States is particularly hard hit by the disease, which is caused by the fungus *Colletotrichum trifollii*.

The new variety is also highly resistant to the pea aphid. Moderate resistance to bacterial wilt disease and to the alfalfa weevil have also been bred into Arc. On production test plots over a 2-year period, annual per acre yields of Arc have totaled 1 to 2 tons more hay than other varieties because of these genetic traits. This means increased protein, much needed by American agriculture.

Arc alfalfa is particularly adapted to growing conditions in most of the Middle Atlantic States, the Southeast, and southern parts of the Midwest. In these areas, anthracnose affects about 4 million acres.

In the Middle Atlantic States, anthracnose is most damaging to alfalfa after the second harvest. Significantly, in the third and fourth harvests, Arc produces double the forage yield of commonly grown susceptible varieties. These differences in yield are all the more important because forage supply is lowest during this period.

The vigorous growth of the anthracnose-resistant Arc also protects the crop against encroachment by weeds. Tests at Beltsville, Md., showed that plots of Arc alfalfa consisted of only 15 percent weeds in late summer—the time when weed problems can be expected to be the greatest. In contrast, stands of seven other varieties of alfalfa were overrun with 50 percent weeds.

Lush spring growth of weevil-resistant Arc alfalfa contrasts with a susceptible variety in a Beltsville test plot. Researchers grow susceptible alfalfa varieties to gauge progress in breeding alfalfa for weevil resistance (0574A640–6A).

Above: Spaced alfalfa plantings are evaluated for alfalfa weevil damage by Dr. Ratcliffe and Dr. Devine. This breeding method was used in developing Arc's weevil resistance (0574A642–27A). ***Right:*** *Research assistant James McMurtey and Dr. Devine measure and record height of vigorous spring growth of Arc alfalfa. Vigor in early growth is an indicator of the variety's resistance to the alfalfa weevil (0574A641–22).*

A third advantage of Arc is stand persistence, owing to the combined resistance to anthracnose and bacterial wilt. These diseases eliminated stands of Williamsburg, Glacier, Cherokee, and Team alfalfa in field tests at Beltsville. Arc, however, has yielded three additional years of good forage after the loss of the other varieties.

ARS entomologist Roger H. Ratcliffe found that Arc is slightly more resistant to the alfalfa weevil—the Number One insect pest of alfalfa—than is Team, a variety released in 1969 specifically for improved tolerance to the insect.

Arc's resistance to the weevil is actually a tolerance to feeding. The crop produces quick, vigorous regrowth after attack by the pest. At four test locations, Arc showed greater tolerance to feeding by the alfalfa weevil than did Team. At three other locations, Arc and Team were equal in their tolerance to the weevil.

Genetic and evaluation studies with more than 40,000 plants were made by 10 scientists in 5 States in the program to develop Arc.

The principal alfalfa sources from which Arc was developed can be traced to breeding programs initiated over 40

Left: Dr. Devine observes yield differences between a susceptible alfalfa variety and the disease-resistant Arc (right). Both samples are from 48-square foot test plot sections now in the fifth season of production (0674A874–16A). Above: Dr. Devine and Mr. McMurtey employ a fixed quadrant stand counting device to determine the exact number of alfalfa plants in one tenth of a square meter. These measurements, repeated in the stands over several years, helped researchers determine the effect of disease resistance on stand persistance of various alfalfa varieties, including the new Arc variety (0574A639–28).

years ago in Kansas and Nebraska. Later, selections for vigor and weevil resistance were carried on at Raleigh, N.C., and Beltsville, Md. Then, using laboratory and greenhouse techniques at Beltsville, ARS geneticist Thomas E. Devine and assistants J. E. McMurtey and J. L. Goodlett developed Arc for high resistance to anthracnose and modern resistance to bacterial wilt.

In testing Arc and other anthracnose-resistant experimental lines in field trials, Dr. Devine found an improvement in performance much greater than had been expected. Results from southeastern Pennsylvania, Maryland, Virginia, and North Carolina showed severe anthracnose damage to susceptible varieties every year at almost all test sites.

The disease resistance developed in Arc stood up consistently at all locations. Later, field tests conducted by ARS agronomist Edgar L. Sorensen at Manhattan, Kans., showed Arc to be highly resistant at that location.

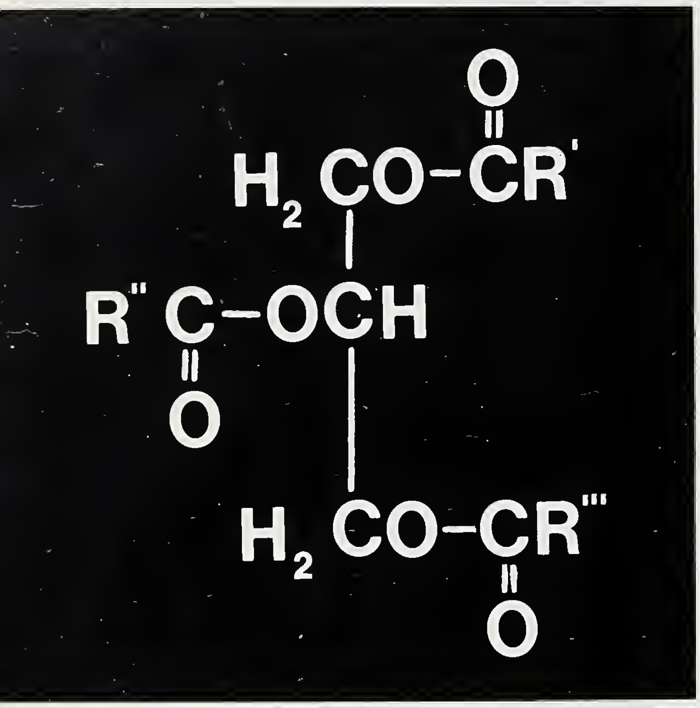
Data on the superiority of Arc were collected over a 5-year period. Maryland, North Carolina, Pennsylvania, and Virginia agricultural experiment stations participated in the work. ☐

Others who participated . . .

ARS agronomist Clarence M. Rincker, Prosser, Wash., produced breeder seed of Arc. ARS geneticist Thad H. Busbice, Raleigh, N.C., and agronomist Clarence H. Hanson, ARS, National Program Staff, cooperated in the development and evaluation of anthracnose resistance and alfalfa weevil resistance of Arc.

Techniques for screening for anthracnose were developed by ARS geneticist Donald K. Barnes, St. Paul, Minn., and ARS plant pathologist Stanley A. Ostazeski, Beltsville. Agronomists John A. Schillinger and Lenat Hoffmann represented the Maryland Agricultural Experiment Station on the project. Agronomist Richard W. Cleveland and plant pathologist Felix L. Lukezic of the Pennsylvania Agricultural Experiment Station conducted tests in Pennsylvania. Agronomist Glenn R. Buss was responsible for tests at the Virginia Polytechnic Institute's Research Division.

Nutrition linked to corn oil geometry



PN–2871

BREEDERS who have been taking advantage of genetically-controlled variations in the chemical composition of corn may have a new principle to consider in developing hybrids that are most nutritionally desirable for livestock and humans.

Fatty acids in the oil of corn exist as components of triglycerides—three fatty acids, each bound to a glycerol molecule. The position on the molecule where various fatty acids are bound affects the nutritional and physiological properties of the triglycerides, said ARS chemist Evelyn J. Weber, Urbana, Ill.

In cooperative studies with the Illinois Agricultural Experiment Station, Dr. Weber, technician Loraine Bollinger and, a former graduate student, plant geneticist Ian de la Roche, found that fatty acids—linoleic, oleic, palmitic, and stearic—were not randomly distributed among the three positions on corn triglycerides, contrary to previous belief. Fatty acid composition at each of the three positions on the triglycerides was different. Moreover, triglycerides from each of 12 strains and several crosses of corn had their own characteristic fatty acid placement, indicating genetic control of their arrangement.

The distribution pattern of fatty acids in corn triglycerides may be important for several reasons, Dr. Weber said. First, instances of oxidation of polyunsaturated fatty acids—developing rancidity—occur most frequently when these acids are bound at the outer positions of the glycerol molecule. Saturated acids, however, are not susceptible to oxidation. If the saturated fatty acids could be concentrated, genetically, at the outer positions and the polyunsaturated fatty acids at the middle position, freshness could be preserved.

Second, whenever oils are digested by an animal, an enzyme—pancreatic lipase—splits off the fatty acids from

The merits of high-oil corn

NUTRITIONISTS say that vegetable oils, by weight, contain about 2.25 times as much energy as starch. If a high-oil corn could yield as many bushels per acre as normal corn, it could trap more calories of solar energy.

Oil content of corn is normally about 4.5 percent by weight, but the percentage can be increased markedly through breeding. Since 1896 plant breeders at the Illinois Agricultural Experiment Station, Urbana, have been developing strains of corn that are either high or low in oil content. The Illinois High Oil strain has reached an oil content of 17 percent. By comparison, soybeans normally have 17 to 22 percent oil content. However, the Illinois High Oil corn strain does not yield well.

Illinois plant geneticist D. E. Alexander and his co-workers have developed several hybrids that contain as much as 8 percent oil with yield performance equal to many widely-grown commercial hybrids.

Growing-finishing pigs made more efficient use of high-oil corn than of normal corn in feeding trials conducted at the Minnesota Agricultural Experiment Station, St. Paul, by animal scientist J. W. Nordstrom. Feed efficiency in beef cattle that are fed high-oil corn is under test at the Illinois Agricultural Experiment Station.

the outer positions of the triglyceride. These free fatty acids are then selectively absorbed through the intestine and may either be metabolized for energy or used for resynthesis of triglycerides or other fats. The fatty acid in the middle position, however, remains bound, leaving a monoglyceride which passes through the intestinal wall intact and then is resynthesized to a triglyceride. Efficient utilization of the polyunsaturated linoleic acid, which is essential in animal diets, is ensured when the acid is bound in the middle position.

Third, some scientists believe that fatty acid placement in the triglycerides people consume, as well as fatty acid composition, may have a bearing on the development of the disease atherosclerosis, in which fatty substances are deposited in blood vessels.

Knowledge that Dr. Weber is gaining on the structure of corn triglycerides also may help increase industrial uses of fatty acids and their derivatives. Technology for separating mixtures of glycerides and fatty acids is improving, she said, as well as the ability of corn breeders to manipulate desired characteristics in the corn plant. □

At Minnesota, Dr. Nordstrom noted that less protein supplement was needed by pigs fed the high-oil corn, probably because the corn was more nutritionally balanced with amino acids.

As an added bonus, pigs fed high-oil corn produced fat higher in polyunsaturated fatty acids than did pigs fed normal corn. Backfat thickness was not increased by the high-oil corn nor did it cause softening of the pork that could have made carcasses unacceptable to meat packers.

Other studies by plant geneticists have indicated that genetic potential exists for modifying independently protein, oil and fatty acid composition in corn. □

Dung beetles combat flies

THE Afro-Asian dung beetle may provide the cattle industry a large measure of relief from manure accumulations and subsequent horn fly populations.

Dung beetles, known to most as scarabs, were sacred to the ancient Egyptians who wore small carved stone replicas as amulets or charms for their magical "protective" powers.

The beetles (*Onthophagaus gazella*) are natural dung feeders and when present in large numbers can rapidly break down manure accumulations, the breeding medium for horn flies.

They break down the manure both by consuming the liquids and also by rolling it into tiny balls that are buried in the ground, each with a beetle egg that will hatch and use the ball as a source of food. By removing the manure, the beetles deprive the horn flies of a place to breed.

In 1972, following 2 years of laboratory study, ARS entomologist Richard R. Blume of the Veterinary Toxicology and Entomological Research Laboratory, College Station, Tex., began releasing beetles in the field. He periodically released 800 to 1,000 beetles over about 1,000 acres both in Victoria and in Kleberg Counties in the Gulf Coast Prairie of Texas.

Follow-up investigations indicate that both colonies are well established and that the colonies have spread over some 5,000 acres in each of the counties.

Results of very limited studies carried out in Victoria County appear to confirm the expectation that where beetles are present in sufficient numbers, the average number of horn flies that emerge from manure can be reduced by as much as 30 to 40 percent.

No quantitative measure was made of the amounts of manure reduction, but Mr. Blume noted that about 50 percent of the manure pats in Victoria County were infested with beetles with a slightly greater infestation in Kleberg County.

The horn fly (*Haematobia irritans*) is a blood-sucking pest primarily of cattle but also of horses and less frequently of sheep. It spends virtually all its time on cattle, leaving only to lay eggs in fresh manure.

The pest's biting irritates beef cattle to the point that they do not eat properly or gain weight as rapidly as they should. In dairy herds milk production often drops significantly. According to 1965 estimates, yearly losses in reduced weight and decreased milk production as a result of horn flies ran as high as $179 million.

Ideally, any agent used as a biological weapon should reproduce rather rapidly. Dung beetles do well in this regard. Each female lays an average of 15 eggs every 10 days. The period from egg to adult beetle is 30 days and adults have a lifespan of about 60 days. Thus, under field conditions, a single pair of beetles could result in a beetle colony 125,000 strong in 3 months with 15,000 new adults emerging each day at the end of this period.

Dung beetles also have the capability of surviving long dry seasons. A newly formed beetle in a dry season may remain in the shelter of its dung ball for several months, emerging only after a good rain. This could be of major importance in the beetle's ability to adapt to dry Texas grazing lands and other dry areas of the country. □

Toward understanding Marek's disease

THE FIRST STEPS have been taken toward identifying the mechanisms by which resistance to Marek's disease is produced in chickens.

Resistance may be genetic, produced by vaccination, or related to the age of chickens, but scientists have not been sure which of several possible means of producing resistance are involved.

Better understanding of resistance could open the way to development of a more effective vaccine against the disease—one that prevents replication of the Marek's disease virus. The widely used herpesvirus of turkeys (HVT) vaccine prevents tumor formation in chickens but has little effect on the virus. Production of an improved vaccine might also serve as a model for prevention of tumor-producing diseases in humans.

In related studies at the Regional Poultry Research Laboratory, East Lansing, Mich., ARS veterinary medical officers Jagdev M. Sharma and H. Graham Purchase found evidence that one form of immune response is not involved in genetic resistance to Marek's disease. They found, however, that immune response may be the basis for resistance conferred by the HVT vaccine.

Dr. Purchase, now with the ARS National Program Staff, explained that immune response mediated by the white blood cells may be of two types—by production of cells that make antibody, a protein substance in blood serum; or by production of "killer" cells that attack foreign substances, such as tumor cells. An immune animal may be resistant because it overcomes the virus infection, or the infected animal may overcome the effects, such as tumor production, but not the infection.

A third possibility is that the disease organism will not grow in the body, so the body makes no response. This is not true of Marek's disease virus in chickens.

In the study, Dr. Sharma tested the hypothesis that genetic resistance to Marek's disease depends on the ability of chickens to produce an antibody such as virus-neutralizing antibody. In chickens, antibody synthesis is a function of cells derived from an organ known as the bursa of Fabricius.

Dr. Sharma surgically removed the bursa from genetically resistant chickens on the 17th day of embryonic life and sham-operated on others. The sham-operation involved opening an incision in the chicken, but not removing the bursa. This guarded against the possibility of the operation itself affecting any difference in antibody production. He then inoculated both groups with a highly pathogenic strain of Marek's disease virus a week after hatching.

Both bursectomized and sham-operated chickens were checked for antibody production by inoculation with sheep red blood cells and tested for hemagglutination at the conclusion of the experiment.

Bursectomized chickens remained resistant to Marek's disease, as did the sham-operated and untreated controls, and antibody was not produced when the bursa was completely removed. This strongly suggested that the form of immune response involving antibody production is not involved in genetic resistance.

Dr. Purchase and Dr. Sharma, in another experiment, investigated what role immune response may have in protection by the HVT vaccine against Marek's disease. They found that resistance conferred by HVT may be a function of the conventional immune system rather than interference with tumor-producing ability as had been thought.

In this experiment, chickens known to be highly susceptible to the disease were chemically bursectomized shortly after hatching by inoculation with the drug cyclophosphamide. The researchers vaccinated the chickens with HVT and 2 weeks later challenged their immunity by inoculating them with a highly pathogenic strain of Marek's disease virus.

The researchers confirmed inability of bursectomized chickens to produce antibody as in the other experiment. In addition, they found that cyclophosphamide slightly reduced mortality but not lesions of the disease. It also eliminated the protection conferred by HVT.

The form of immune response produecd by HVT was not fully determined, however. Dr. Purchase pointed out that cyclophosphamide has a major effect on the bursa but also has some effect on the thymus, the source of "killer" cells in chickens. □

Plant pathologist Chris G. Schmitt examines the bleached (chlorotic) stripe stage of downy mildew development on sorghum leaves. The chlorotic stage is the diagnostic stage of the disease as seen in the field. The sorghum plants are being grown under strict quarantine experimental conditions at the Plant Disease Research Laboratory in Frederick, Md. (Sorghum-Dis-0-4).

Should an epidemic strike...

What are the risks that foreign plant diseases will spread to the United States and wipe out thousands of acres of crops before anyone identifies the pathogens and finds a solution?

Such risks are regarded seriously enough to keep a team of 10 plant pathologists, an entomologist, a plant physiologist, and supporting staff busy full time in preventive studies at the ARS Plant Disease Research Laboratory, Frederick, Md.

"Increasing world trade and international travel multiply the risks to U.S. crops from plant diseases now found only abroad," said Charles H. Kingsolver, who heads the Frederick laboratory. "We must assume that foreign pathogens will gain entrance sooner or later. We can't afford to wait for a new destructive disease to appear before initiating study. We need to know in advance how big a threat it will be in this country, and how it can be handled if it does get in.

"The Plant Disease Research Laboratory is developing new knowledge on the vulnerability of our major crops to exotic diseases," Dr. Kingsolver said. "This knowledge is put to work in related research on ways to protect those crops.

"Stem rust of wheat is a classic example of a plant disease that 'got away'," Dr. Kingsolver notes. "It may have come with the wheat brought by early settlers, and it could have been introduced repeatedly into this country when foreign varieties of wheat were obtained at various times." Today, the

Right: *Dr. Schmitt examines leaves for evidence of spore production by a downy mildew fungus on corn and sorghum plants in a "dew chamber." Plants lose heat by radiation to the chilled chamber walls as warm moisture-laden air rises from the heated water at the base of the chamber. Because the fungus,* ***Sclerospora sorghi****, sporulates readily under moist conditions, this special chamber is used to simulate environmental conditions under which dew forms (Corn-D&P-0-15).*

Above: *Downy mildew spores, seen here on the undersurface of a corn leaf, are very fragile. They are seen most readily during periods of dew formation (Corn-D&P-0-16).* ***Right:*** *Pustules of the subtropical corn rust fungus,* ***Puccinia polysora****, form on the leaves and sheaths of the corn plants grown under quarantine conditions at the Frederick lab. Corn germplasm is being screened for resistance to this fungus which causes yield losses in many corn growing areas of the world (Corn-D&P-0-13).*

Above: Pustules of soybean rust fungus show up as brown and white areas on the undersurface of a soybean leaflet. Soybean rust is an important disease in Australia, India, Indonesia, Taiwan, and other Far East countries (Soy-D&P-0-29). ***Right:*** Yellowing and blanching of new leaves and reddening of older leaves are symptoms of maize dwarf mosaic virus on sorghum. Sorghum varieties, used to separate and differentiate strains of this virus, may be potentially useful as indicators for the detection and identification of non-endemic viruses of corn and sorghum (Sorghum-Dis-0-3).

One of the many foreign diseases to which the corn is exposed to under the quarantine conditions is tropical corn rust. The rust, caused by the fungus ***Physopella zeae****, produces severe yield losses for corn in Tropical South America (Corn-D&P-0-12).*

Plant pathologist J. Stanley Melching explains the process of spore innoculation in a settling chamber at Frederick. Spores placed in the nozzle in the center of the chamber base are propelled by an air blast into the chamber. The spores fall and impact uniformly on the plants as they rotate and revolve on a circular table (Corn-D&P-0-14).

stem-rust fungus regularly destroys about 4 percent of the U.S. wheat crop, causing losses that cost growers $80 million in an average year.

In consultation with world authorities on crop diseases, Dr. Kingsolver and his staff have reviewed literature on more than 1,000 pathogens that infect crops grown abroad. Pathogens considered most dangerous to our major crops are being selected for intensive study.

Field investigations at overseas locations are planned to supplement the research here.

The potentially most important diseases of corn, soybeans, and wheat not yet established in this country have been chosen for the scientists' first studies at Frederick. Their approach is to study the pathogen — how it operates, how the disease progresses — and ways to predict its future spread, and countermeasures to control it.

Foreign pathogens are studied under strict quarantine at the Plant Disease Research Laboratory. "To our knowledge, there is nothing else like it," Dr. Kingsolver said in describing the tight containment precautions observed at the Frederick facilities. Specially designed greenhouses permit simultaneous study of up to 10 pathogens, each isolated in a separate greenhouse unit, under virtually foolproof safeguards against escape of the disease organisms.

Safety glass of double-thickness is used in the greenhouses. Materials entering or leaving are sterilized by steam or ethylene oxide. Scientists and other workers must shower as they leave the greenhouses, to prevent hitchhiking of exotic organisms to the outside. A shower before entering greenhouses is sometimes required, to protect plants from infection by outside organisms. Special clothes must be worn in these greenhouses and laboratories and, after use, left there for steam sterilizing before laundering.

As an additional precaution, the greenhouses and associated laboratory rooms are operated at an air pressure lower than that of the outside atmosphere. Thus, should any small leaks develop in these facilities air is drawn inward instead of escaping to the outside.

Pathogens in the air are trapped in special filters that capture particles as small as 0.5 micron. Bacteria cannot pass through these filters — it would be like trying to pass a thick telephone book through a keyhole.

Precautions are also taken against escape of pathogens in the Laboratory's waste water. All waste water is flushed through a special sewer system, which goes through a steam sterilizer before entering the conventional sewage treatment plant.

"No description of this laboratory would be complete without considering the consumer's stake in this research," Dr. Kingsolver noted. Food prices could be expected to increase from crop shortages caused by plant diseases. The Plant Disease Research Laboratory has a vital mission in helping to prevent such shortages — especially in view of the rapidly increasing world population which will require greater food production in the years ahead. □

Mote grooves make a comeback

A simple, easy-to-use cutting device could increase roller ginning efficiency by nearly 40 percent. The device takes the difficulty out of cutting and maintaining mote grooves in ginning rollers used in roller gin stands.

Mote grooves—narrow spiralled slots cut lengthwise in the surface of the roller—were once a part of roller ginning techniques but were more or less "phased out" during the 1960's. At that time, most of the industry replaced reciprocating knives with rotary knives to aid in the removal of seeds from the cotton. That innovation raised the ginning efficiency about four-fold, bringing it up to an acceptable level without using mote grooves.

With the development of the new cutting device, and its simplicity in cutting new mote grooves or maintaining old ones, an additional efficiency is possible.

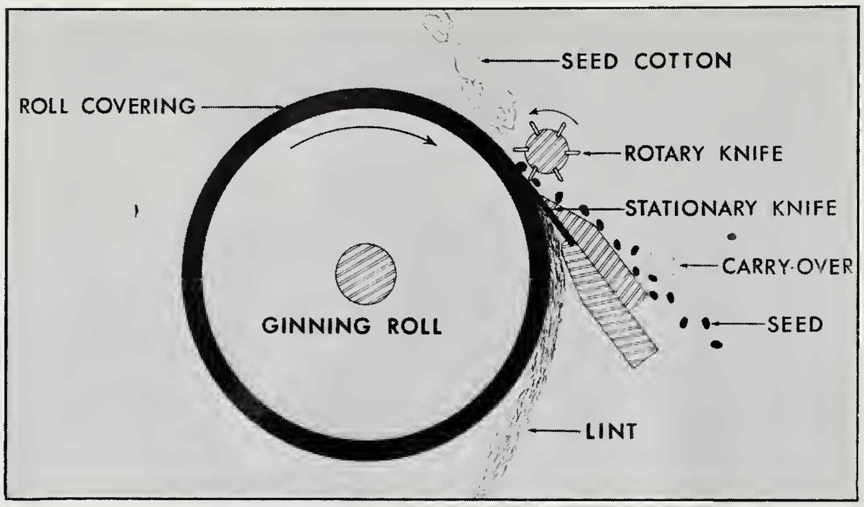
Roller gins are used to gin the extra long staple American Pima cottons produced in the western United States. The high quality of these extra-long staple cottons is better preserved in roller ginning than in its counterpart, the saw gin, which is used to gin upland cottons. Most of the extra long staple cottons are used in the manufacture of thread and fine cloth that require high quality fiber.

The ginning roller and the stationary and moving knives are the primary components of the roller gin stand. A ginning roller consists of a central shaft and a wooden or metal cylinder covered with a resilient material, usually a laminated cotton canvas and white rubber packing material.

When cotton is ginned by the roller method, the stationary knife, installed lengthwise over the roller, intercepts the seeds as the cotton clings to the roller. The cotton fibers follow the roller

Above: Edward A. LeBlanc demonstrates the mote groove cutting device on the rotary knife roller gin stand. As the guide roller and cutting blade are cranked across the roller, the pressure of the guide turns the gin roller, cutting a spiraled groove across the face of the roller. The device is attached to the rear of the gin stand in this photo (0774X1062–14).
Left: Physicist Clarence G. Leonard stands by one of the roller gins in operation at the Southwestern Cotton Ginning Research Laboratory. The long stack on the gin stand is an experimental air dust control system, related to another project at the lab involving in-plant air quality (0774X1064–9A).

Rotary knife roller gin



A cross section drawing shows how the rotary knife, working against the stationary knife, separates the cottonseed from the lint (PN–2868).

beneath the knife. As the seeds are held by the stationary knife, the rotary knife blades pass over the stationary knife removing the seeds from the cotton fibers.

Motes or small defective seeds, in the absence of grooves, find their way under the knife, hang there, bunch up the cotton, cut down on efficiency, and sometimes tear or wear away the roller. Mote grooves, moving along the stationary knife in a spiral pattern, temporarily relieve the pressure and allow

Above: *Mr. LeBlanc demonstrates the time-consuming method of cutting mote grooves by hand (0774X1062–12).* ***Right:*** *The mote groove cutting device can be used on the roller gin stand or on a lathe as shown here. The blade cuts a groove 10 times faster than the old hand method (0774X1061–17).*

the motes to pass harmlessly beneath the knife with the cotton.

The mote groove cutting device consists of a guide roller, a cutting tool, and a two-piece adjustable base fixture that fits on a lathe or can be fitted onto a gin. New rollers can be "mote grooved" with the tool either in a lathe or in place on the gin stand.

The new device was developed by ARS machinist Edward A. LeBlanc, under the guidance of agricultural engineer Ivan W. Kirk and physicist Clarence G. Leonard, at the Southwestern Cotton Ginning Research Laboratory, Las Cruces, N. Mex.

The key to the new tool is the guide roller which can be set at any desired angle—usually 30 degrees—pressed into the soft roller surface either in the lathe or on the gin stand, and moved horizontally in a straight line.

With the roller free to rotate, the roller and cutting tool move along the lathe and the roller is turned by the pressure of the guide roler at the exact angle at which it is set. Modifications of the same idea make it possible to cut or renew mote grooves in rollers on the gin stand.

In the past, grooves were cut by hand using a V-shaped wood carving tool or with a portable circular saw. Neither of the methods was desirable because of the difficulty in cutting a 30 degree spiral by hand or by doing the same with a circular saw. Recutting grooves when the roller surfaces were worn was just as difficult. □

Left: *Operation of the roller gin without mote grooves reduces efficiency because carry-over material clogs the machine (0774X1062-30).* ***Below left:*** *However, with the mote grooves on the rotary knife roller gin, very little carry-over clogs the gin during removal of the seeds from the lint (0074X1062-21A).*

Meet the rain measurer

THE ACHE in the broken bone, the stillness of the air, the movements of birds and animals, the sailor's observations on sunsets, all reflect the age-old effort to understand and predict the elusive changes of the weather. People have relied on such folk wisdom for centuries and generations of farmers once were guided by the confident tone of the farmer's almanac as it detailed the weather day by day for an entire year.

ARS meteorologist David M. Hershfield is more cautious in his observations on the weather: "Almanac predictions are like horse races—you remember the winners." For the past 25 years (13 with ARS, 12 with the U.S. Weather Bureau) he has been trying to provide reliable probabilities of extreme weather events.

Dr. Hershfield is now investigating the probabilities of dry periods in the Midwest during the 70's. A potential for drought exists there because the Midwest seems to go through 20-year cycles of dry periods. The region was hit by notable dry periods there in the 30's and 50's.

"Indeed a drought did occur this summer," Dr. Hershfield said, "with varying degrees of severity along a line from northern Texas to North Dakota and also extending into adjacent States. This was primarily due to dry, hot weather in July. This dry event, however, does not necessarily presage a dry period the following year.

"The problem is that we need to learn what the whole system is all about," Dr. Hershfield said. The many variables involved in trying to understand the complex interaction of the atmosphere, oceans, and polar ice masses in weather predictions have led some experts to believe that a 2-week forecast may be the maximum that can ever be achieved. A recent panel on the present interglacial period, chaired by Dr. Hershfield, concluded that not enough is known about climate predictability to say whether long-range predictions are even a realistic possibility.

Much of Dr. Hershfield's recent research deals with the probability of heavy rainfalls. Surrounded by filing cabinets loaded with weather data in his office at the Hydrograph Laboratory at Beltsville, Md., Dr. Hershfield is not in the business of day-to-day predictions. He studies long-range patterns and probabilities of rainfalls. One study, for example, dealt with the probable occurrence of extremely heavy 1-minute rainfalls. The world record for 1 minute of rainfall is 1.23 inches observed at Unionville, Md.

In another study on the probability of extreme rainfall events, Dr. Hershfield clarified the definition of a "100-year storm."

The ability to estimate the probability of once-in-a-century storms is of great importance to agriculture in terms of erosion control and to engineering for the design of flood control structures. The probability of extreme storms of short duration is important in designing culverts and storm drainage systems.

Research conducted by Dr. Hershfield on the frequency of freeze-thaw cycles has application to agriculture because soil temperatures influence seed germination and plant establishment. In some cases, freezing can force plants out of the ground.

Dr. Hershfield's studies of dry periods continue. He does not like to use the word "drought," because drought means something different to the farmer, the hydrologist, the meteorologist. Developers of ski resorts even use the term to refer to snow drought. ☐

P.L. 480 Research

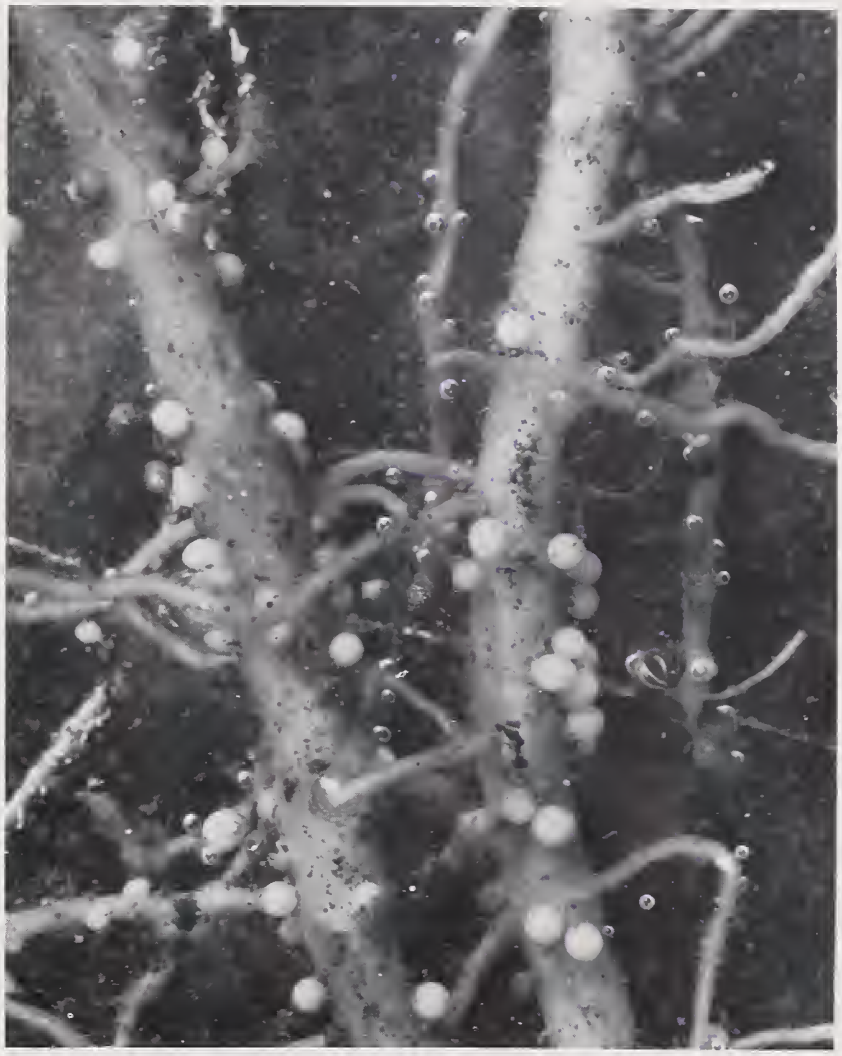
Soil amendments reduce root-knots

ORGANIC SOIL AMENDMENTS have proved helpful in the biological control of root-knot on vegetables in tests conducted by Indian scientists.

Root-knot is a disease caused by nematode species of the genus *Meloidogyne* which stimulate cell development, resulting in enlargement of root systems and formation of root galls. Infested plants are paler in color, wilt more easily, and die early. All U.S. crop losses from parasitic nematodes are estimated at $1.6 billion annually. The yearly damage to vegetables alone is estimated at over $2.5 million.

In an ARS-sponsored project, Indian scientists found that oil cake applied to fields 3 weeks before planting significantly reduced root-knot damage to vegetable crops. The oil cake was applied at a rate of 5,500 pounds per hectare (2.47 acres). Oil cakes are the organic concentrated residues resulting from the extraction of oil from seeds of legumes and other oilseed-bearing plants.

Fewer nematode females, eggs, and larvae were found in the root tissues of plants growing in the amended soil than in the nonamended soil. Also, the egg-laying capacity of the females was reduced by about 50 percent.



Root-knot disease, shown here on potato roots, is insidious because it is difficult to detect until irreparable damage has been done. Crops that are hosts for the disease-causing nematodes include tomatoes, celery, spinach, cabbage, tobacco, cucumbers, sugar beets, and cotton (BN–271).

The Indian plant pathologists also experimented with wood sawdust as a substitute for oil cake. However, since the ratio of carbon to nitrogen in sawdust is very high, it was necessary to counteract the nitrogen deficiency by adding inorganic nitrogen. Maximum yields and disease control were obtained with the application of 264 pounds of nitrogenous fertilizer per hectare to the sawdust-amended soil at the time of planting.

The Indians also assayed different fractions of extracts of amended soil and found that the decomposition products of these materials contain substances such as volatile fatty acids and phenols that can be toxic to nematodes.

These findings—taken with the concept that rich, organic soil matter encourages the activity of parasites, pathogens, and other antagonists that may suppress nematodes—suggest that more than one mechanism is involved in the reduction of root gall severity in amended soils. For example, the Indians suggest that better nutrition of the host and changes in root physiology may also play a major role in reducing infection.

The Indian research was conducted under the provisions of Public Law 480 and was directed by Dr. R. S. Singh and Dr. K. Sitaramaiah at the G. B. Pant University of Agriculture and Technology, Pantnagar. Dr. Joseph M. Good, Washington, D.C., and Dr. Burton Y. Endo, Beltsville, Md., were the ARS-cooperating scientists. □

Another sex attractant synthesized

Scientists have isolated and identified the sex pheromone of the tobacco budworm and have used identical synthetic chemicals to catch males in traps.

The synthetic attractant will be used in traps to survey population densities and for early-season detection of the pest in cultivated host-plant areas. Quite possibly, broad-area application of the attractant will lead to suppression of entire populations.

Tobacco budworms are resistant to most commonly used pesticides. Losses to this pest are estimated to be well over $100 million each year. The insect persists in southern U.S. latitudes during most of the year and has devastated host crops in more southerly countries including Mexico and isles of the Caribbean.

Primary host plants attacked are cotton and tobacco, but several staple vegetable crops are included on the budworm's menu. These include tomatoes, potatoes, corn, okra, and many other wild and cultivated plants when preferred hosts are not available.

Nearly 5 years of extensive biological and chemical studies were completed before the pheromone was characterized and synthesized. About 3 million tobacco budworms were used in quality control bioassays and chemical extraction and isolation procedures. Most of these moths were produced in a large mass-rearing facility in southern Texas.

In a major cooperative effort, ARS entomologist Donovan Hendricks at the Cotton Insects Research Laboratory, Brownsville, Tex., and chemist James Tumlinson at the Insect Attractants, Behavior and Basic Biology Research Laboratory, Gainesville, Fla., isolated and tested both the natural attractant and identical synthetic compounds.

Both were tested in large field cages where males had been released and in open fields of various cultivated plant hosts that supported wild male moths. Collaborative support was also given by chemist Robert E. Doolittle and entomologist Everett R. Mitchell at the Gainesville Laboratory.

Two compounds were identified as components of the sex pheromone. Both are aldehyde-type molecules, and both are rather colorless liquids. Neither of the chemicals is effective alone. Both are necessary and they must be presented in the same ratio produced by the female—about 16 to 1.

The mixture is highly volatile and carried by air currents to males primed to respond to the chemical mating call of the female. Because of the high vaporization rate, the pheromone is short-lived. □

Improving the environment for poultry

An inexpensive temperature and humidity control system can be readily adapted to the ventilation and heating equipment of existing poultry houses.

The system, known as a "time-proportioning temperature and humidity control system," was developed by ARS agricultural engineers Floyd N. Reece and Frederick W. Harwood at the South Central Poultry Research Laboratory, Mississippi State, Miss. The equipment is basically a thermostat which can be set to control both ventilating and heating equipment simultaneously. The cost for the system components is about $100.

The ARS researchers tested the system for 4 years in research broiler houses at the laboratory and for another 2 years on a commercial egg farm. A Long Island duck producer has also used the system successfully in rearing houses. Research shows that hens will lay more and eat less at a temperature of 70° F. During brooding, a 90° F. temperature is desirable, but during the 4-week grow-out period the temperature should be lowered to 70° F.

Relative humidity also needs to be controlled because dry litter can cause dusty conditions. Dust can lead to reduced performance, failure of ventilation and heating equipment, and health dangers for the human operator.

The new system operates in cycles of 5 minutes. A thermostat, in conjunction with a time relay, determines the percentage of each 5-minute cycle that the ventilation fans must operate to maintain the desired temperature.

The heaters operate for the remainder of the 5-minute cycle, minus any delay provided by a second time-delay relay. The second relay controls the relative humidity in the poultry house. As the time delay is increased, the relative humidity increases.

The system will operate with any type and number of fans. Separate motor contactors are required because the electric relays in the system are not designed to operate electric motors directly. The heaters must be equipped with electrically operated gas control valves to provide 100 percent shutoff if the gas pilot light fails. □

Sweeter orange juice

HOUSEWIVES and citrus processors may one day applaud tiny soil-borne bacteria for producing enzymes that take the bitterness out of processed orange juice.

ARS chemists at Pasadena, Calif., are adding microbial enzymes to orange juice before it is processed to prevent the formation of substances that cause the bitterness.

Bitterness in the juice is caused by an intensely bitter substance called limonin. Limonin is formed in the juice by acid-catalyzed conversion from its natural precursor, limonate A-ring lactone. The juice acids (primarily citric acid) and the precursor are in different compartments in the fruit tissues and do not come into contact until the fruit is juiced. The same bitterness can be caused at home when oranges are squeezed and the juice allowed to stand for a time before being served.

Naval oranges are the most affected, although other oranges, lemons, and grapefruit share the problem to lesser degrees. Processed naval orange juice presently loses about a third of the market price because of the bitterness.

Scientists thought that persons could not detect limonin bitterness below 6 to 8 parts per million (ppm), but they have since discovered that subtler palates can taste the substance at levels as low as 0.5 ppm.

The two enzymes, discovered by chemist Shin Hasegawa, Subtropical Fruit Laboratory, degrade the limonoate A-ring lactone to a stable nonbitter product. Current investigations show that the enzymes degrade the limonoate A-ring lactone in 15 minutes, faster than the acid-catalyzed bitterness conversion to linonin.

Commercial use of this simple debittering process would require no change in the present juice production facilities. A number of major citrus producers have expressed interest in the process, as have several enzyme manufacturers.

Reducing flight stresses

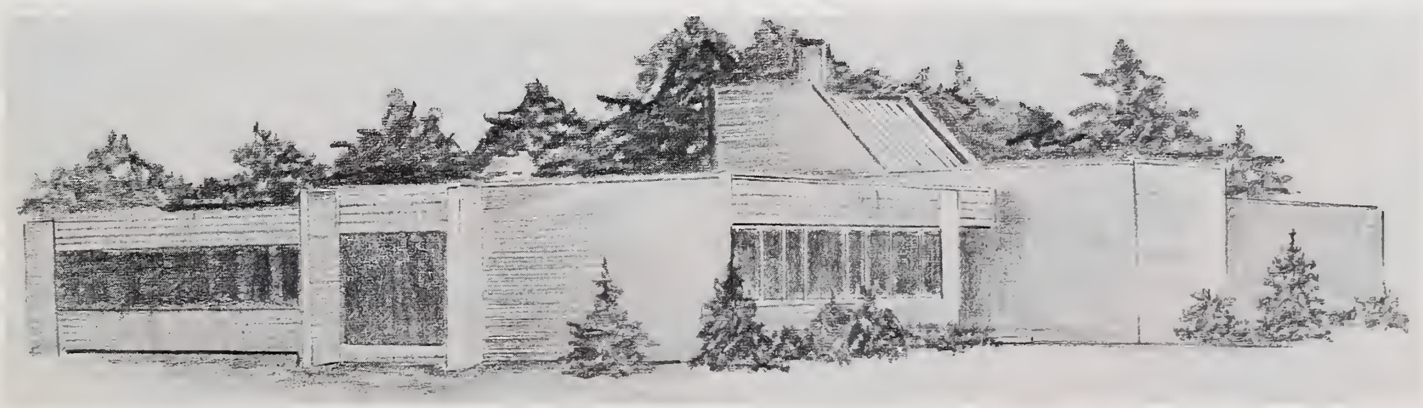
GUIDELINES for providing suitable environmental conditions for livestock during air shipment have now been provided for livestock shippers by USDA's Animal and Plant Health Inspection Service (APHIS) in the publication *Environmental Considerations for Shipment of Livestock by Air Freight* (APHIS 91–21).

Assembling of the information was a joint effort of ARS agricultural engineers Donald G. Stevens and G. LeRoy Hahn, Columbia, Mo., and Theodore E. Bond, Clemson, S.C., and APHIS veterinarian John R. Langridge, Hyattsville, Md.

The scientists said problems of providing suitable conditions for livestock are similar to those encountered in providing human transportation. The problems are multiplied, however, by the animals' production of large amounts of heat and metabolic by-products. While most shipments are successful, livestock encounter such stresses as: temperature and humidity excesses and fluctuations, noise, vibration, water deprivation, dust, odors, carbon dioxide and ammonia buildup, air pressure fluctuations, handling, and fatigue.

Acclimation, the physiological adjustment of the livestock to their environment, should be considered when temperature and relative humidity is regulated in the aircraft, the scientists said. They recommended that environmental conditions be gradually adjusted during flight to the conditions which the animals will encounter upon arrival at their destination.

Free single copies of the publication are available upon request from APHIS–VS, USDA, Rm. 809A, Federal Center Building, Hyattsville, Md. 20782.



New lab dedicated
ARS' newest research facility, the New England Plant, Soil, and Water Laboratory at Orono, Me., was recently dedicated. The new laboratory is designed to house 25 employees, including eight ARS and two State scientists. It contains six laboratories, nine offices, a shop, and a sample preparation room. The new laboratory will be operated in cooperation with the Maine Life Sciences and Agricultural Experiment Station, University of Maine, Orono (PN–2870).

AGRISEARCH NOTES

Prodigious pollinators

HONEY BEES upheld their reputation as prodigious pollinators in a recent strawberry study. Open strawberry plots or strawberry plots caged with honey bee colonies produced larger and better quality fruit than plots screened to exclude bees.

Little attention has been given to the role of insects in pollinating strawberries. Self-fertile cultivars apparently set fruit well without insects. Recent studies, however, indicate that insect visits are essential for complete pollination of some cultivars.

ARS entomologist William P. Nye and pomologist J. LaMar Anderson, Utah State University, Logan, explored the effects of pollination by honey bees on the yield of three strawberry cultivars in Utah.

The researchers planted double row beds of "Fresno," "Shasta," and "Tioga" strawberries. At the onset of flowering they set up the following conditions in replicas of four: open plots available to all insects; plots screened to prevent access by any large pollinating insect; and plots in cages containing a four-frame honey bee colony. When all tertiary bloom was complete, the men removed the cages.

Screening out large pollinating insects reduced yields because the berries were smaller. Also, plots without large insects produced significantly more malformed fruit because of incomplete ovule fertilization and lack of tissue development around undeveloped seeds. Open plots and plots with caged bees gave superior yields.

Based on the study, Mr. Nye says, "Because of the large investment in strawberry production, growers should consider providing honey bees unless there are already significant numbers of colonies located near their plantings."

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

PROTECT
Use Pesticides Safely
FOLLOW THE LABEL

Seedling cold injury

THE little-understood mechanisms by which sugarbeet seedlings suffer cold injury have been exposed in recent studies.

Untimely spring frosts often kill sugarbeet seedlings, causing economic problems for beet growers. Until now factual knowledge has been scarce.

ARS soil scientist John W. Cary, Snake River Conservation Research Center, Kimberly, Idaho, studied freeze injury to sugarbeet seedlings under controlled laboratory and growth chamber conditions. His results indicated that two mechanisms may be involved in seedling survival: osmotic pressure and the amount of sap that can be converted to ice without killing the seedling.

Increasing plant sap osmotic pressure in a seedling increases its resistance to frost. Dr. Cary increased the osmotic pressure by using high levels of soluble salts around a beet's roots during germination.

During germination, beet tolerance for ice increases with cooling temperatures, allowing a large amount of sap to be frozen before the seedling suffers.

Dr. Cary found that two soluble salts, potassium nitrate and potassium chloride, offered the best protection.

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